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Assessment of cloud heterogeneities effects on brightness temperatures simulated with a 3D Monte-Carlo code in the thermal infrared

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Clouds are key parameters in the climate and radiative budget of the Earth. They are however difficult to handle due to their high spatial variabilities of their microphysical (size, shape) and macrophysical properties (optical thickness, fractional coverage, cloud top variation…). Clouds are indeed three-dimensional structures but retrievals algorithms of cloudy parameters are generally based on the IPA (Independent Pixel Approximation) because of operational constraints. This approximation assumes clouds as plane-parallel homogeneous and infinite layers, and can then introduce errors in the computation of the thermal brightness temperature and thus on retrieval of optical and microphysical parameters.

This study assesses the effects of 3D heterogeneities on thermal brightness temperature. For it, we needed to couple a 3D radiative transfer code with a code of generation of realistic cloudy scene. The generation of a three-dimensional uncinus cirrus clouds is build by a stochastic model named 3DCLOUD (developed in the LaMP, Laboratoire de Météorologie Physique) in respect to realistic atmospheric conditions. Then, for the radiative transfer we have extend the 3DMCPOL code to the thermal infrared, this code is a 3D Monte-Carlo algorithm write in the LOA (Laboratoire d'Optique Atmosphérique). Comparisons have been performed between a 3D reference brightness temperature fields and with the equivalent IPA fields. They have been made in the IIR/CALIPSO radiometer bands (8.65 μm, 10.60 μm and 12.05 μm) and for different cirrus cloud parameters (heterogeneity degree, optical thickness, ice particles size and shape…).